MERRIMACK RIVER BASIN

SALEM, NEW HAMPSHIRE

WEST DIKE
ARLINGTON MILL RESERVOIR
NH 00029

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

The original hardcopy version of this report contains color photographs and/or drawings. For additional information on this report please email

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

AUGUST 1978

West Dike, Arlington Mill Reservoir, Salem, New Hampshire: phase I inspection report, National Dam Inspection Program. -- Waltham, Mass. : U.S. Army Corps of Engineers, New England Division, 1978.
vi, [45] p. : ill., maps ; 28 cm. -- (NH00029)
"August 1978"

West Dike, Arlington Mill Reservoir, Salem, New Hampshire: ... 1978.
(Card 2)

UNCLASSIFIED

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READ INSTRUCTIONS BEFORE COMPLETING FORM

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ver program reads: Phase I Inspection Report, National Dam Inspection Program; wever, the official title of the program is: National Program for Inspection of n-Federal Dams; use cover date for date of report.

KEY WORDS (Continue on reverse side if necessary and identify by block number)

AMS, INSPECTION, DAM SAFETY,

errimack River Basin
lem New Hampshire
icket River

ABSTRACT (Continue on reverse side if necessary and identify by block number)

he dam is a small earth fill saddle dike 230 ft. long and 10 ft. high. The dike s assessed to be in overall good condition, although it is not without problems. t is recommended that the owner cure the roadway erosion problem, and to more ligently protect the dike from further alteration.

FORM 1473 JAN 73 EDITION OF 1 NOV 65 IS OBSOLETE

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED

SEP 28 1978

Honorable Meldrim Thomson, Jr.
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

Dear Governor Thomson:

I am forwarding to you a copy of the West Dike Arlington Mill Reservoir Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, Spicket River Corp., 550 Broadway, Lawrence, Massachusetts 01841.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Water Resources Board for your cooperation in carrying out this program.

Sincerely yours,

JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

WEST DIKE

ARLINGTON MILL RESERVOIR

NH 00029

MERRIMACK RIVER BASIN
SALEM, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam West Dike, Arlington Mill Reservoir

State Located New Hampshire

County Located Rockingham

City or Town Salem

Stream Spicket River

Date of Inspection 6/7/78 and 6/28/78

Brief Assessment

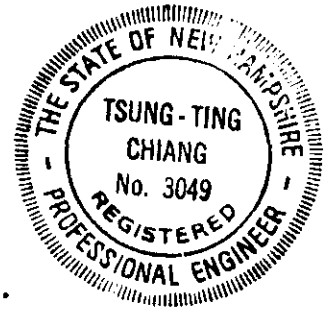
The West Dike of Arlington Mill Reservoir is a small earth fill saddle dike 230 feet in length and 10 feet high. The dike was built uder the same contract as Wheeler Dam on Arlington Mill Reservoir and was completed in 1922. The swale on which it is built has a low point one foot below the spillway crest elevation of Wheeler Dam, rendering the West Dike a very low head structure under normal conditions. The dike has no spillway or discharge conduits, as these functions are performed at Wheeler Dam.

The West Dike is assessed to be in overall good condition, although it is not without problems. Several unwise alternations have taken place since construction, and roadway drainage has formed erosion paths in the unprotected upstream face. However, in making an evaluation, the non-menancing nature of the site offsets these problems and uncertainties.

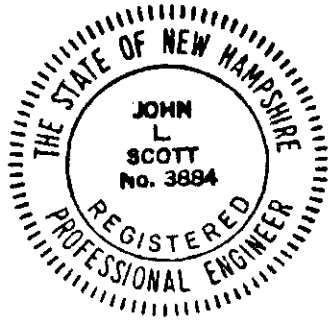
The reservoir test flood (equal to the probable maximum flood) would overtop the West Dike by about one foot. The choice of test flood is dictated by the much higher hazard classes of Wheeler Dam and the East Dike. If the test flood were chosen by the "low" hazard classification of the West Dike only, the peak flow would be much lower, and the dike would not be over-topped.

It is recommended that the owner cure the roadway erosion problem, and to more diligently protect the dike from further alteration.

WHITMAN & HOWARD, INC.



T. T. Chiang, Ph.D., P.E.



John L. Scott, P.E.

This Phase I Inspection Report on the West Dike, Arlington Mill Reservoir has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Charles G. Tiersch

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

Fred J. Ravens Jr

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

Saul Cooper

SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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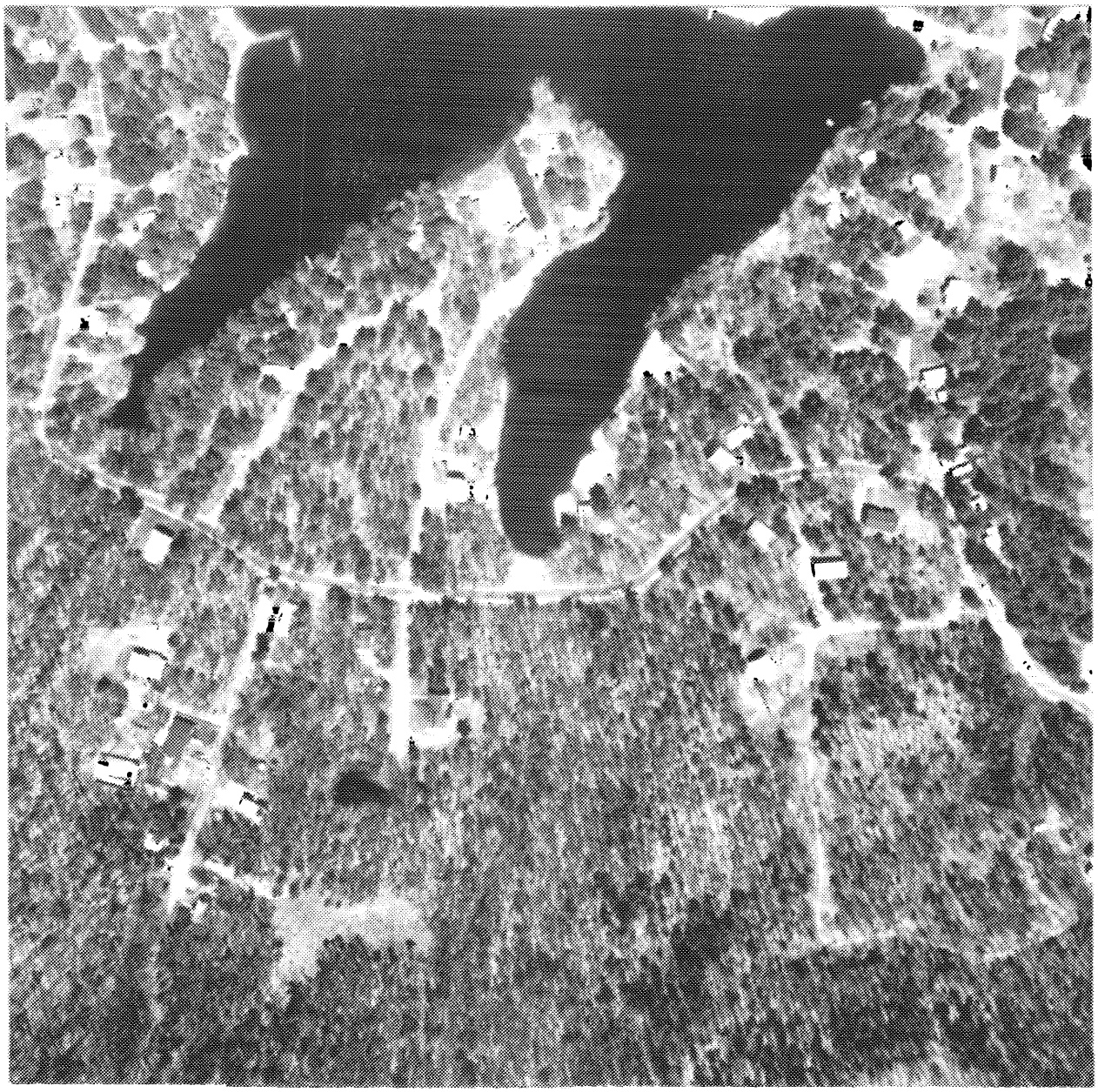


WEST DIKE

ARLINGTON MILL RESERVOIR

Salem, N.H.

Approx. Scale 1" = 280'

WHITMAN & HOWARD, INC. WELLESLEY, MASS. ENGINEERS & ARCHITECTS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

WEST DIKE

ARLINGTON MILL RESERVOIR

SALEM DEPOT, N.H.-MASS. U.S.G.S. QUAD.

NAME OF RIVER SPICKET STATE N.H.

SCALE 1:24,000

DATE JULY, 1978

PHASE I INSPECTION REPORT

WEST DIKE, ARLINGTON MILL RESERVOIR

NH 00029

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Whitman & Howard, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed was issued to Whitman & Howard, Inc. under a letter of May 1, 1978 from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW33-78-C-0313 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project:

a. Location - The West Dike is located about 2,000 feet west of Wheeler Dam on the shore of Arlington Mill Reservoir in the Town of Salem, New Hampshire. It appears on the U.S.G.S. quadrangle "Salem Depot, NH - Mass."

b. Description of Dam and Appurtenances - The West Dike is an earth fill embankment without concrete core wall. It is a saddle-type dike built across a natural swale. The low point of the swale is at elev. 159, one foot below the spillway crest of Wheeler Dam. During normal times, the West Dike retains a very low head of water. Total length is about 230 feet and the maximum height is 10 feet. The upstream face is on a 3:1 slope and paved with hand placed riprap, although this has been filled out with beach sand on an approximately 6:1 slope. Downstream face is also on a 3:1 slope. There is no outlet or spillway as these functions are performed at Wheeler Dam. An access roadway serving lake shore cottages has been built across the crest.

c. Size Classification - The low height and small volume of water actually impounded, places the West Dike squarely in the "Small" classification.

d. Hazard Classification - If the West Dike were to fail or to be overtopped, flow would travel south joining Widow Harris Brook, the outlet of Millville Lake. This stream meanders easterly and flows into the Spicket River about 1-1/2 miles downstream from Wheeler Dam. The Spicket River flows from there through Salem, Metheun, and Lawrence, where it joins the Merrimack. The low height of the flood wave generated, coupled with the sparse population in the area likely to be effected, places the West Dike in the "Low" hazard class. Some damage is quite likely, though loss of life would not be expected.

e. Ownership - Ownership and water rights are integral with Wheeler Dam. Present owner is

the Spicket River Corp. of Lawrence, Mass. The dike has always been in the hands of the owners of the former Arlington Mills in Lawrence.

f. Operator: Harlan Low
550 Broadway
Lawrence, Mass. 617/686-3846

g. Purpose of Dam - The West Dike was built in conjunction with Wheeler Dam and the East Dike to create Arlington Mill Reservoir. the purpose was to store water and regulate flow for an industrial mill complex located on the Spicket River in Lawrence, Mass.

h. Design and Construction History - The West Dike was built under the same contract as Wheeler Dam, and was completed in 1922. Chief engineer was H.K. Barrows of Boston, Mass.

i. Normal Operational Procedure(s) - No operation as such.

1.3 Pertinent Data

a. Drainage Areas

23.5 sq. mi., of which 17.1 are controlled at Big Island Pond Dam upstream.

b. Discharge at Damsite

No discharge at West Dike - see Wheeler Dam report for discharge date of Arlington Mill Reservoir.

c. Elevation (ft. above MSL)

(1) Top Dam - 169

(2) Maximum pool-design surcharge - 166

(3) Full flood control pool - N/A

(4) Recreation pool - 160 (Wheeler Dam flashboards at 162.1)

(5) Spillway crest (gated) - No spillway

(6) Upstream portal invert diversion tunnel - None

Downstream portal invert diversion tunnel -None

(7) Streambed at centerline of dam - 159 (not a stream - low point of swale)

(8) Maximum tailwater - No tailwater

d. Reservoir

(1) Length of maximum pool - Approx. 11,000 ft. @ elev. 168

(2) Length of recreation pool - 9,600 ft. @ elev. 160

(3) Length of flood control pool - N/A

e. Storage (acre-feet) - Not counting dead storage

(1) Recreation Pool - 270 ac-ft (between elev. 160 and 159)

(2) Flood control pool - N/A

(3) Design Surcharge - 1,970 (@ elev. 166)

(4) Top of Dam - 2,910 (@ Elev. 169)

f. Reservoir Surface (acres)

(1) Top Dam - Est. 320

(2) Maximum pool - Est. 300

(3) Flood-control pool - N/A

(4) Recreation pool - Measured 266 at elev. 160

(5) Spillway crest - N/A

g. Dam

(1) Type - Earth embankment w/o core wall

(2) Length - 230 ft.

(3) Height - 10 ft.

(4) Top Width - 10 ft.

(5) Side Slopes - Upstream 3:1 (covered with beach sand to 6:1); Downstream 3:1

(6) Zoning - Noted "earth fill" on plans - no zoning

(7) Impervious core - None

(8) Cutoff - Trapezoidal trench with "impervious fill"

(9) Grout curtain - N/A

h. Diversion and Regulating Tunnel - None

i. Spillway - None

j. Regulating Outlets - None

SECTION 2: ENGINEERING DATA

2.1 Design

Plans show the West Dike was designed as a homogeneous embankment placed on natural ground after the surface had been stripped of loam and mud. The plans show a small trench, several feet wide and several feet deep and containing "impervious fill" where needed, cut into the natural ground along the centerline of the dike. The drawing shows that this trench did not extend to "ledge" (bedrock). The drawing also shows that the upstream slope of the dike was to be riprapped, but it has since been covered with beach sand. No other information is available about the foundations or the design of the embankment. See Plate in Appendix B.

2.2 Construction

A few photos and brief mentions in inspection reports exist.

2.3 Operation

The dike is not operated as such.

2.4 Evaluation

a. Availability - Construction plans, a few construction photos and reports are available, but none are very detailed.

b. Adequacy - Because the available information does not include descriptions of the soils in the foundation and embankment, it is not adequate for evaluating the stability of the dike.

It should be mentioned that the project was inspected by the design engineer, H.K. Barrows, a prominent Boston engineer.

c. Validity - There are no records of when the road was built, when the beach sand was added, and the details of suction hydrant installation.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General - This is a low, small structure with an obviously low hazard potential.

b. Dam - The original structure has been modified with the addition of a roadway across the top, beach sand on the upstream face, and a suction hydrant installation presumably extending a pipe into the lake laid in a dug and backfilled trench.

Erosion of the sand has occurred in places. Trees and shrubs cover the downstream face and part of the upstream face. There is a wet spot about 20 feet downstream of the dike, although it is most likely a high groundwater condition and not seepage.

c. Appurtenant Structures - N/A

d. Reservoir Area - Cottage development extensive.

e. Downstream Channel - N/A

3.2 Evaluation

There is no evidence from the visual inspection that the dike is unstable.

Erosion of unvegetated sandy area on the upstream slope, and the growth of trees and brush on the slopes could lead to future problems if not remedied.

Because no information is available concerning the hydrant installation, it is not possible to evaluate whether the buried section of the pipe provides a path for seepage, thereby posing a threat to the safety of the dike.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures - No operation as such.

4.2 Maintenance of Dam - None apparently performed.

4.3 Maintenance of Operating Facilities - N/A

4.4 Description of any warning system in effect - None

4.5 Evaluation - Due to the inconspicuous nature of the West Dike, it is vulnerable to unknowledgeable alteration. The owner must be diligent to prevent such an occurrence.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

Hydraulically, the West Dike is part of Wheeler Dam. The top elevation of the West Dike is the same as for the earth embankments of Wheeler Dam (169). No hydraulic design criteria is known for Wheeler Dam.

b. Experience Data

There is no history of overtopping, and no such visual evidence.

c. Visual Observations

There is nothing to observe from a hydraulic standpoint.

d. Overtopping Potential

Since the West Dike is effectively a part of Wheeler Dam, the overtopping potential is identical. It should be mentioned that if the test flood were chosen by the low hazard classification of the West Dike only, the peak flow would be much less, and the dike would not be overtopped. The following section is verbatim from the Wheeler Dam Phase I report.

Reference is made to Appendix D for the hydrologic computations performed as a part of this report.

The peak inflow into Arlington Mill Reservoir of the Probable Maximum Flood (PMF) is computed to be about 22,300 cfs. The PMF is defined as the largest flood that can reasonably be expected to occur on a given stream at a selected point, or the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

For structures of the size and hazard classification of Wheeler Dam, the "test flood" is generally selected as the full PMF. The test flood is that flood used to evaluate the hydraulic adequacy of a project. The test flood for Wheeler Dam is chosen as the full PMF.

If the upstream Big Island Pond Dam were to remain intact during the test flood condition, the peak inflow into Arlington Mill Reservoir would be reduced from 22,300 cfs to about 17,000 cfs, due to the surcharge storage effect in Big Island Pond. However, it has been determined that Big Island Pond Dam will likely fail under flows well below this test flood. (See Phase I report for Big Island Pond Dam, NH 00470.) Therefore, the evaluation of the hydraulic adequacy of Wheeler Dam should not rely upon the surcharge effect of Big Island Pond.

Assuming Wheeler Dam remains intact, the peak outflow during the test flood would be about 19,800 cfs, the reduction from the inflow of 22,300 cfs being accounted for by the surcharge storage effect of Arlington Mill Reservoir. At the moment of this peak outflow, the water surface would be about 170.3 ft. msl or 1.3 ft above the top of the earth embankments of Wheeler Dam and also those of the East Dike and West Dike.

The spillway capacity of Wheeler Dam, including the capacity of the three discharge conduits and also the extra capacity of one foot of flow over the main concrete portion, is computed to be about 12,600 cfs, or 64% of the peak outflow during the test flood. Overtopping potential is judged as moderate.

It must be mentioned that should Big Island Pond Dam fail suddenly in the later stages of a severe flood (after building up a large hydraulic head) the impact of the resulting flood wave could wipe out Wheeler Dam and the two dikes.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations - Refer to Section 3. There are no signs of structural movement or distress.

b. Design and Construction Data - Conservatively shaped; very low average head. Data is absent regarding soils and foundation geology.

c. Operating Records - N/A

d. Post construction changes - Roadway, beach sand, and suction hydrant installation added. Effect on safety is unknown, but probably minimal.

e. Seismic Stability - The structure is located in Seismic Zone 2 and hence need not be evaluated, according to OCE guidelines.

SECTION 7: ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition

The West Dike is assessed to be in good overall condition. The problems and unknowns are offset in large part by the non-menacing nature of the site. At normal lake level, the head of water is only one foot.

A number of operation and maintenance proced ures should be followed as outlined below.

b. Adequacy of Information

Fair to poor - General picture well known, but soils and geologic information is such that the evaluation must be based on the results of the visual inspection.

c. Urgency

The recommendations and remedial measures mentioned below should be carried out within two to four years.

d. Necessity for Additional Investigation

No need for more detailed inspection exists at this time.

7.2 Recommendations

a. The owner should take steps to prevent continued erosion of the upstream face by surface runoff from the roadway.

7.3 Remedial Measures

a. Alternative - N/A

b. Operation and Maintenance Procedures

(1) The trees and brush growing on the embankment and for a distance 20 feet

downstream of the dike should be removed annually.

(2) During period when the reservoir level is high, the dike, the dike and downstream area should be observed for evidence of seepage, piping, or other signs of instability.

(3) It is recommended that the owner adopt a program of regular observation visits by a responsible individual. Visits should be at least weekly and a permanent log kept.

(4) The owner should be more diligent in protecting the integrity of the structure from further alteration.

WEST DIKE

APPENDICES

Appendix	Description
A	Visual Inspection Checklist - 3 pp.
B	Engineering Data with Index
C	Inspection Photographs with Index - 5 photos
D	Hydrologic Computation
E	Information as Contained in the National Inventory of Dams

APPENDIX A

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT West Dike
Arlington Mill Reservoir

DATE June 7, 1978*

TIME start 11:00 AM

WEATHER warm, sunny

W.S. ELEV. 162.2 U.S. none DN.S.

PARTY:

1. T.T. Chiang, W&H
2. John Scott, W&H
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Entire Dike	Chiang & Scott	
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

*Inspected second time - see next sheet

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT West Dike, Arlington Mill Reservoir

DATE June 28, 1978*

TIME 4:00 PM

WEATHER warm, sunny

W.S. ELEV. 162.0 U.S. none DN.S.

PARTY:

1. John Scott, W&H
2. Ronald Hirschfeld, Geotechnical Engineers, Inc.
3.
4.
5.
6.
7.
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Entire Dike	Scott & Hirschfeld	
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

*Second inspection - see previous page for details of first inspection.

PERIODIC INSPECTION CHECK LIST

PROJECT West Dike Arlington Mill Reservoir DATE 6/7/78 and 6/28/78

PROJECT FEATURE Entire dike NAME Entire party

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
DIKE EMBANKMENT	
Crest Elevation	Roadway pavement OK
Current Pool Elevation	162.2 on 6/7, 162.0 on 6/28
Maximum Impoundment to Date	Unknown
Surface Cracks	None
Pavement Condition	Roadway pavement OK
Movement or Settlement of Crest	None
Lateral Movement	None
Vertical Alignment	OK
Horizontal Alignment	OK
Condition at Abutment and at Concrete Structures	Good at abutments; no concrete structures
Indications of Movement of Structural Items on Slopes	No structural items
Trespassing on Slopes	Upstream slope used as boat launch - probably swimming also
Sloughing or Erosion of Slopes or Abutments	Sand erosion from crest roadway
Rock Slope Protection-Riprap Failures	Riprap (if built) is buried with beach sand
Unusual Movement or Cracking at or near Toes	None
Unusual Embankment or Downstream Seepage	Wet spot 20 ft. downstream of toe - probably high groundwater, not seepage
Piping or Boils	None
Foundation Drainage Features	None shown on drawings or observed
Toe Drains	None shown on drawings or observed
Instrumentation System	None

APPENDIX B

WEST DIKE

INDEX TO ENGINEERING DATA

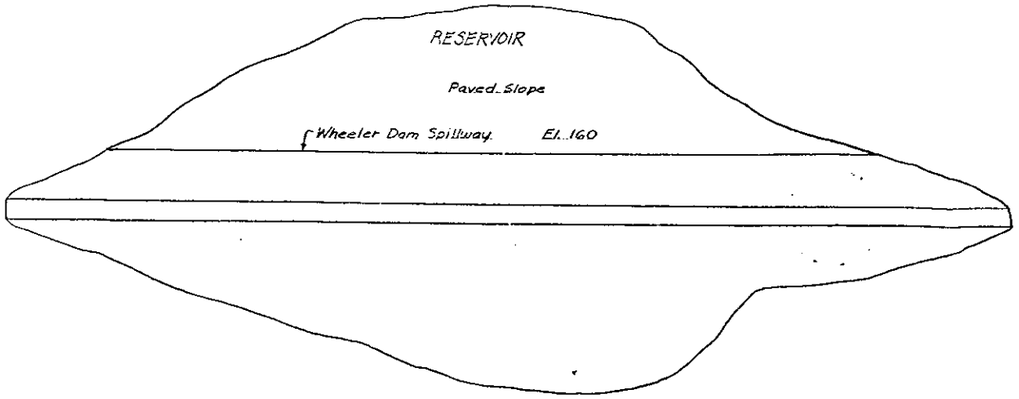
Plate - Plan and Section

N.H. Water Resources Board Dam Safety Inspection Form
(undated, probably 12/73)

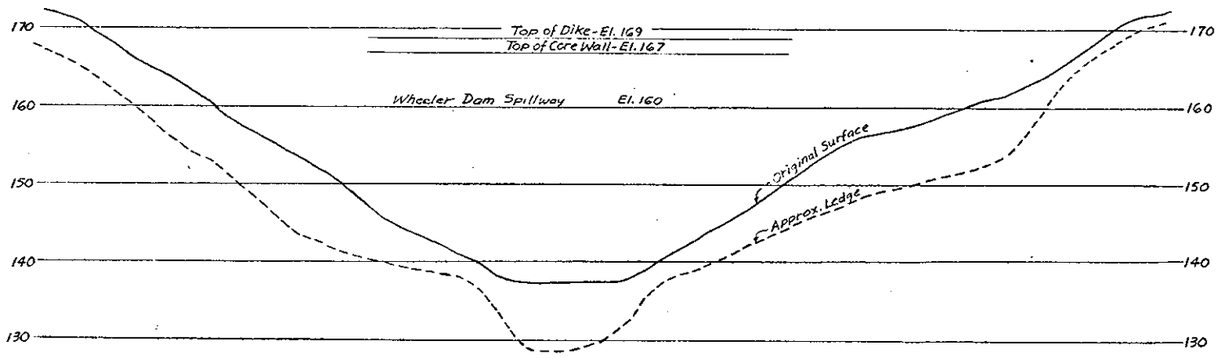
Photograph, 10/30/35

Construction photograph, 11/16/21

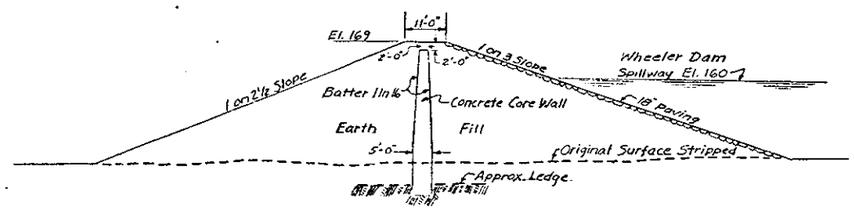
Chief Engineer's Design Memorandum, 7/31/20



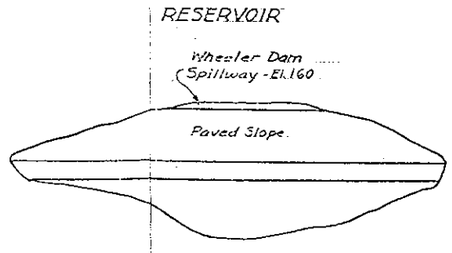
PLAN



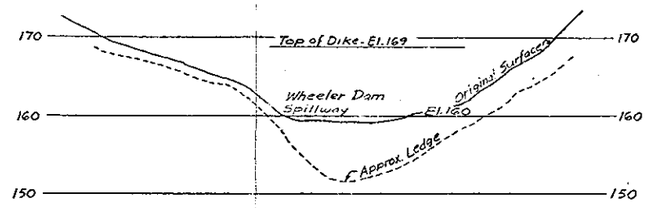
PROFILE



EAST DIKE



PLAN

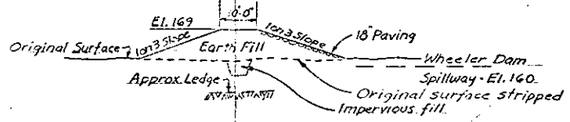


PROFILE

HORIZ. SCALE IN FEET

40 20 0 40 80 120

VERT. SCALE 4:1 EXAGGERATION



TYPICAL SECTION

WEST DIKE

NOTE: Paved roadway across crest. Upstream face filled out with beach sand to approx. 1 on 6 slope.

Job No. 8-081 Job No. 8-083

Traced from original plans dated July 1920, modified to suit.

All elevations are USGS mean sea level datum.

HORIZ. SCALE IN FEET

20 10 0 20 40 80

WHITMAN & HOWARD, INC. ENGINEERS AND ARCHITECTS WELLESLEY, MASS.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

EAST AND WEST DIKES
ARLINGTON MILL RESERVOIR

SPICKETT RIVER NEW HAMPSHIRE

SCALE AS SHOWN
DATE JULY, 1978

N. H. WATER RESOURCES BOARD
Concord, N. H. 03301

DAM SAFETY INSPECTION REPORT FORM

Town: SALEM Dam Number: 209.06

Inspected by: ZSD Date: _____ 19____

Local name of dam or water body: SPICKETT RIVER

Owner: SPICKETT RIVER CORP. Address: _____

Owner was/was not interviewed during inspection.

Drainage Area: ± 23 sq. mi. Stream: _____

Pond Area: _____ Acre, Storage _____ Ac-Ft. Max. Head _____ Ft.

Foundation: Type _____, Seepage present at toe - Yes/No, _____

Spillway: Type _____, Freeboard over perm. crest: _____,

Width _____, Flashboard height _____,

Max. Capacity _____ c.f.s.

Embankment: Type _____, Cover _____ Width _____,

Upstream slope _____ to 1; Downstream slope _____ to 1

Abutments: Type _____, Condition: Good, Fair, Poor

Gates or Pond Drain: Size _____ Capacity _____ Type _____

Lifting apparatus _____ Operational condition _____

Changes since construction or last inspection: _____

Downstream development: _____

This dam would/would not be a menace if it failed.

Suggested reinspection date: _____

Remarks: DID NOT LOCATE

No. 209.06

ARLINGTON RESERVOIR IN SALEM
Arlington Mills
October 30,1935

Salem Dam.

West Dike

Nov. 16, 1921.

M. AM. SOC. C. E.
CONSULTING ENGINEER
6 BEACON STREET
BOSTON

ARLINGTON MILLS WATER SUPPLY

WHEELER RESERVOIR

Memorandum by H. K. Barrows, July 31, 1920, accompanying letter to N.H. Public Service Commission.

WHEELER RESERVOIR

The general extent of this reservoir is shown on sheet 1019.45. It is located on Spicket River in the town of Salem and will extend from the vicinity of Wheeler's Mill (burned a number of years ago and not rebuilt) to North Salem - a distance of about 1.5 miles. The drainage area of Spicket River tributary to this reservoir will be about 22 square miles.

As planned, the level of the permanent spillway of the main dam will be at elevation 160 (datum approximate mean sea level) and the capacity of the reservoir when drawn to elevation 140 will be about 1,000 million gallons. The elevation of the present mill pond at the old Wheeler Mill is about 133. As noted further, it is planned to arrange the spillway of the main dam so that 1 ft. flashboards can be carried if desired, which will increase the capacity of the reservoir above elevation 140 to a total of about 1,100 million gallons.

The water area of the reservoir at elevation 160 will be about 270 acres.

CONSTRUCTION REQUIRED

In addition to the main dam near the old Wheeler Mill, there will be required two dikes at low places in the watershed. These are shown on sheet 1019.47 as the East and West Dikes respectively.

Borings and test pits have been made and ledge rock located at both dam and dike sites.

As will be noted, a section of the highway leading from Salem to North Salem is to be discontinued and in lieu of this a new road constructed lying easterly from the East Dike and connecting with existing roads, which are also to be reconstructed. The highway at North Salem will also have to be raised for a few hundred feet, and at at least one other point on the highway adjacent to the reservoir a slight fill made. These changes were authorized by the Town of Salem on July 10, 1920.

MAIN DAM

Details of the main dam are shown on sheet 1019.46. Its total length will be about 730 feet, consisting of a 100 ft. spillway at El. 160, and about 380 ft. of bulkhead section, all of concrete. The interior portion of the concrete will be in the proportion of 1-3-6, with occassional large stones embedded in the concrete. tThe exterior portion. of the concrete are to be in the proportion of 1-2½-4. The remaining portion of the dam at each end will consist of earth fill with concrete core wall, the concrete to be 1-3-6.

The maximum height of the spillway section is about 28 ft. above ledge rock with crest at El. 160, arranged so that 12 inch wooden flashboards can be carried by wrought iron pins. The latter are proportioned so that they will bend over and the flashboards go out if the head of water on the crest of the dam reaches 4 ft.

The bulkhead section will have a maximum height above bed rock at the present river bed of about 53 ft. The bulkhead section for a length of 160 ft. near its highest portion will be curved upstream in plan, with a radius, on the downstream side, of about 665 ft.

In the bulkhead section is to be a gate house through which will run three 48 inch steel pipes set in the concrete of the dam, each arranged with a 48 inch circular sluice gate with gate control and lift in the gate house at the top of the dam. The westerly pipe is intended for power use of water, is to be arranged with racks and can be later extended down stream a short distance to a suitable power house location. The other two 48 inch pipes are intended for use in releasing water from the reservoir. ← Never done

DIKES (See sheet 1019.47)

East Dike

The East Dike will be about 530 ft. long constructed of earth fill with concrete core wall. The top of the dike will be at El. 169, the top of core wall 167. The upstream

half of the dam is to be of impervious earth fill carefully rolled, the downstream half of less carefully selected material but well compacted. The concrete core wall is to be in the proportion of 1-3-6 and to extend into ledge or impervious foundation. Further details are shown on the plan.

The maximum height of the East Dike above the present surface is about 31 ft.

West Dike

As will be noted by reference to sheet 1019.47, this is a low structure, the present ground level being only a little below El. 160 at the middle of the dike location. The maximum height of the dike with top at El. 169 is about 10 ft. This will be of earth fill, as noted on the plan, but without concrete core.

APPENDIX C
ARLINGTON MILL RESERVOIR, NH - WEST DIKE
GEI PHOTO DESCRIPTIONS

Photo No.	Description
1	Upstream slope of dike looking south from water's edge to crest of dike. Edge of paved road on crest of dike at top of photo. Some erosion of sand immediately below pavement edge.
2	Paved roadway on crest of dike looking from east abutment to west abutment (approximately at location of parked car). Pavement in generally good condition. Trees and brush on downstream (left in photo) side of dike. Unvegetated upstream slope of dike at center of dike (to right of portion of paved roadway which is sunlit across the entire roadway width). Some brush and trees on upstream slope near both east and west abutments.
3-5	Sequence of 3 photos taken clockwise from west abutment, showing: central section of upstream slope which is unvegetated sand, brush on upstream slope near both east and west abutments, utility pipe projecting above ground near upstream edge of paved roadway, and reservoir (visible between clumps of brush at left-center of photo) (3); paved roadway on crest of dike, with east abutment at location where road rises significantly in the background (4); and downstream slope of dike (in right of photo) which is covered with brush (5). Trees and brush cover the ground downstream of the dike. About 20 ft downstream of dike, but not visible in photo there is a wet spot and some standing water. This spot appears to reflect a high water table in the generally low, flat area downstream of the dike and does not appear to be due to seepage through the dike.

1

2

3

4

5

APPENDIX D

HYDROLOGIC COMPUTATIONS

WATERSHED MAP

APPENDIX D

BY T.I.C. DATE Aug. 78 PROJECT Army Corps Eng'rs SHEET NO. 1 OF 7

CHKD. BY DATE Dam Safty Inspection JOB NO. 8-081, 082, 083

Arlington Mill Reservoir

East Dike	1922	31'
Wheeler Dam	1917	32'
West Dike	1922	10'

I. Hydrology & Hydraulic Data.

a) Drainage Area = At Dam site D.A is 23.5 sq. mile includ Big Island Pond D.A of 16.7 sq. mile

b) Watershed Characteristics.

River channel Slope ≈ 0.0288 — Major Drainage Area.
Side drainage area slope West ≈ 0.048
East ≈ 0.052

Big Island Pond discharges into Arlington Mill Reservoir, within a 23.5 sq. mile drainage area these are both good sized reservoirs. Therefore the Basin should be classified as flat-rolling-land type.

c) Water surface Area = 266 Acres at El. 160± (Spillway Crest Elevation)

d) Storage Capacity: Based on N.H. Water Resources Board: Storage for the top 20 ft is about 3030 Acre-ft. Usually the Drawdown curve start at spillway crest. The top five feet has storage capacity of 1200 Acre-Ft, therefore, the estimated maximum storage should be about 5400 Acre-ft, (Normal storage would be about ≈4200 Acre-ft.) This assumes that water surface would reach top of the concrete portion of the dam (El. 163) and the spillway crest (El. 160) respectively.

Therefore, All three embankments (Wheeler Dam, East Dike, West Dike) should be classified as intermediate dam category.

WHITMAN & HOWARD, INC.
45 WILLIAM STREET, WELLESLEY, MASS.
Engineers and Architects

e) Probable Max. Flood Flow. Based on D.A = 23.5 sq. mile

Estimated Peak PMF for Rolling Land = 1400 cfs/sq. mile D.A
" Flat Area = 600 cfs/sq. mile D.A
Avererage = 950 cfs/sq. mile D.A.
Peak PMF = 950 x 23.5 = 22,325 cfs

f) Existing Spillway Capacity: Neglecting wave action

Top of Earth embankment at El. 169
Top of Concrete Gravity Dam at El. 168
Spillway crest Elev. 160
Spillway length (Ogee Section) 100 Ft

Spillway Max. Capacity when water at Top of Dam (El. 168)
$= 3.8 \times 100 \times 8^{3/2} = 8600$ cfs

But the concrete gravity section of Dam can be overtopping at about 1 ft during emergency; than the peak spilling capacity
$= 3.8 \times 100 \times 9^{3/2} + 335 \times 3.0 \times 1^{3/2}$
$= 10260 + 1005 = 11{,}265$ cfs $\simeq$ ½ Peak PMF

There are 3 – 4' diameter gates, only one operatable at present, the other two have not been operated for long time. Assume all three can be fixed and operated and use it as emergency spillway. the capacity of the 3 gates is:

$Q = \sqrt{\frac{40}{1.75}} \times 8.03 \times (3 \times 4 \times 3.14) = 1450$ cfs When tailwater lower than outlet.

This would bring the total emergency spillway capacity to about 12,600 cfs.

g) Discharge Flow Rating Curve:
The total length of earth embankments including main Dam, West Dike and East Dike is about 3010 ft in length. Treat it as abroad Crested Weir with discha

Coefficient of 2.7 (Usually C = 2.67 to 3.05 for broad crested weir).

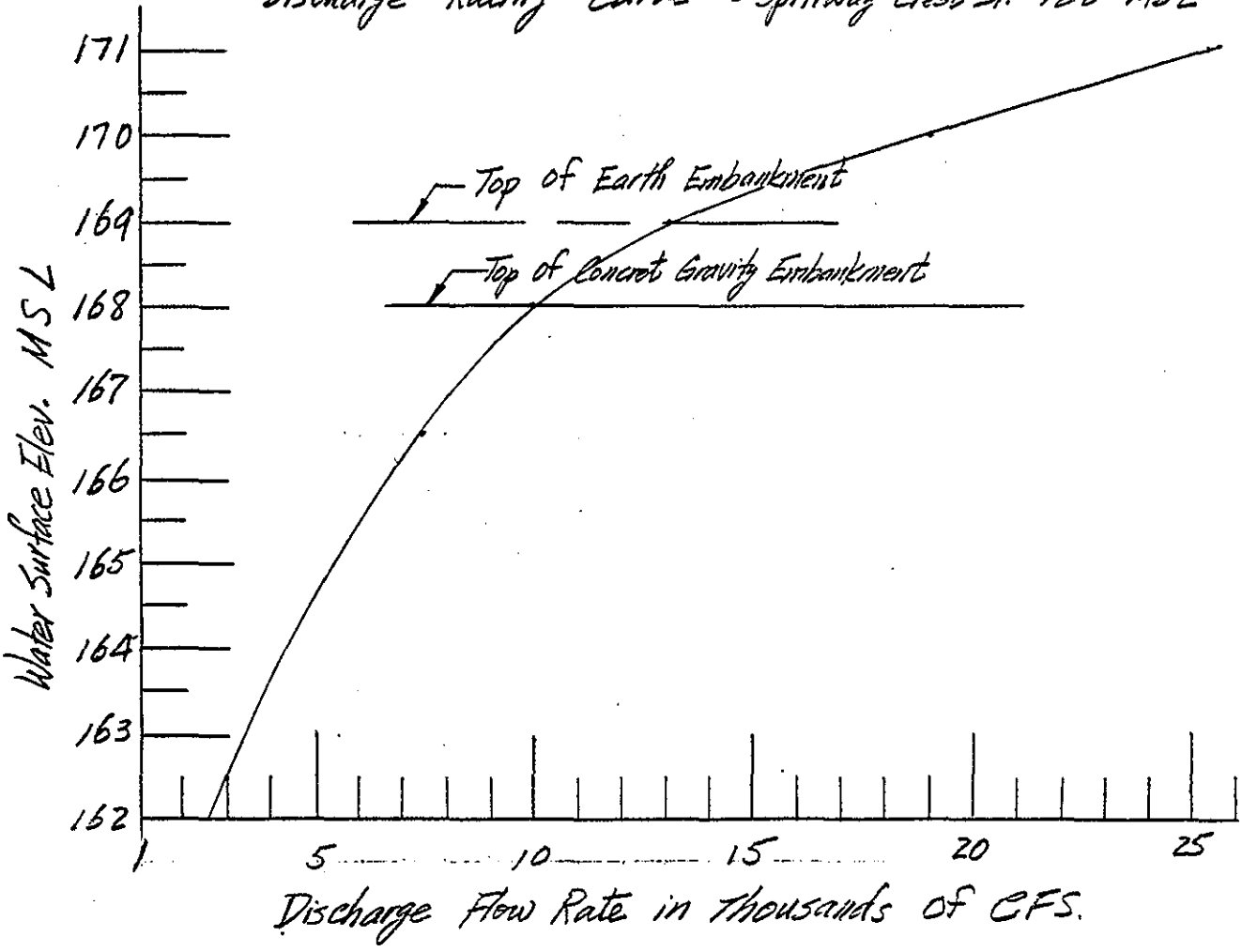
For water surface at level 1 ft above the top of earth embankment, discharge flow rate would be

$$Q = 3.8 \times 100 \times 10^{3/2} + 335 \times 3.0 \times 3^{3/2} + 1010 \times 2.67 + 1450$$
$$= 12,016 + 2843 + 2697 + 1450 = 19,006 \text{ cfs}$$

For water surface at level 2 ft above the top of earth embankment, discharge flow rate would be

$$Q = 12,016 (1.1)^{3/2} + 2843 \left(\tfrac{3}{2}\right)^{3/2} + 2697 (2)^{3/2} + 1450$$
$$= 13863 + 5223 + 4800 + 1450 = 25336 \text{ cfs}$$

Discharge Rating Curve = Spillway Crest El. 160 MSL



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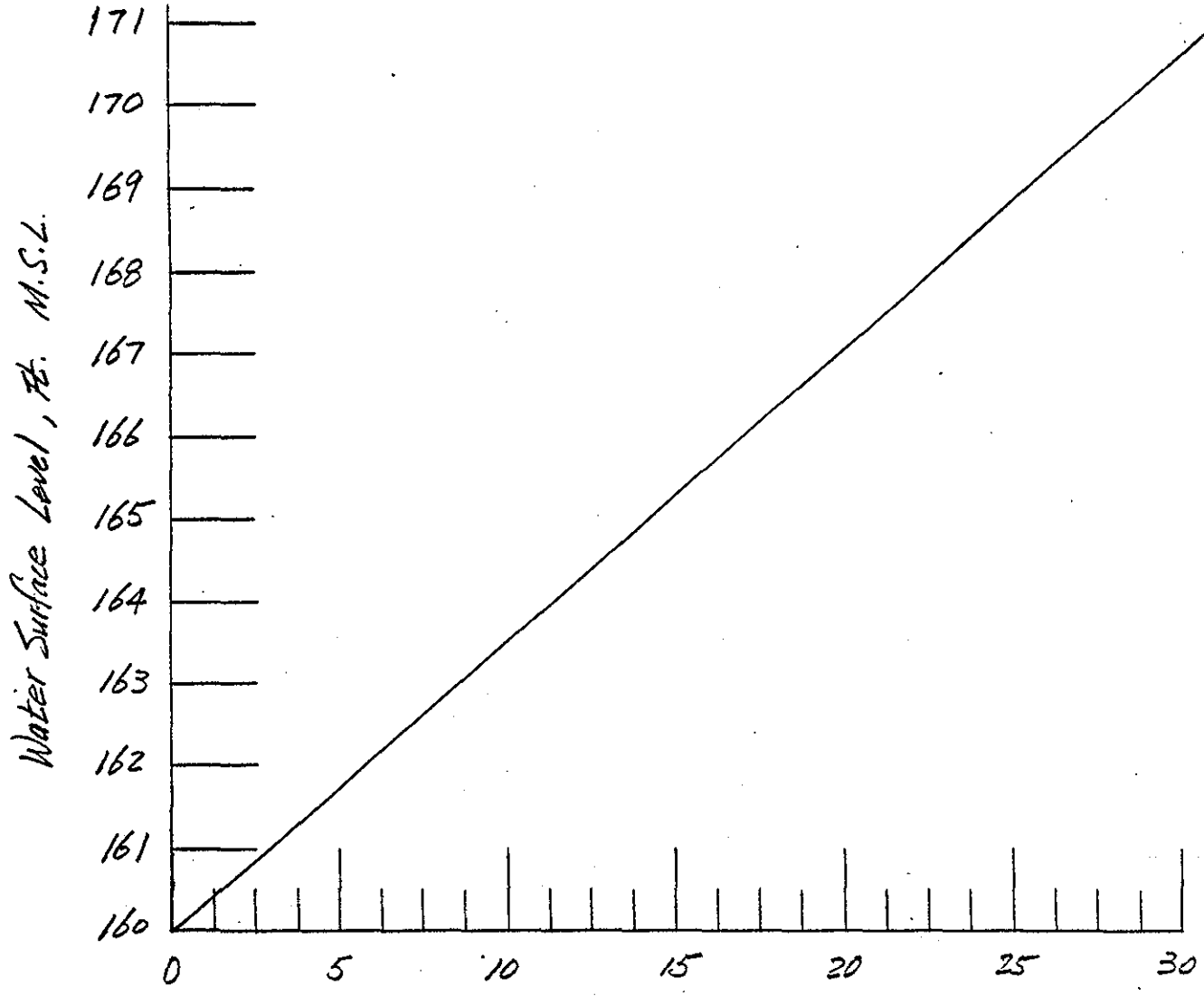
Engineers and Architects

h) Surcharge Capacity (= Water Surface Area x Surcharge depth) and its effect



For QPI = 22,330 cfs from discharge rating curve

$H_1 = 170.5 - 160 = 10.5$ Ft

$STOP_1 = 10.5 \times 266 \times 1.562 \times 10^{-3} \times 12/235$

$= 2.228$ inch

$QP2 = QP1 (1 - 2.228/19) = 19,685$ cfs

$H_2 = 171.2 - 160 = 10.2$ Ft

$STOP_2 = 2.228 (\frac{10.2}{10.5}) = 2.164$ inch

$STOP_{ave} = (2.164 + 2.228)/2 = 2.196$ inch

$QP3 = QP1\left(1 - \frac{2.196}{19}\right) = 19{,}749$ cfs

$\therefore H = 170.3 - 160 = 10.3$ Ft About 1.3 Ft overtopping the earth embankment

i) Consider Big Island Pond Surcharge Effect.

If Big Island Pond Dam does NOT FAIL at peak PMF then, the discharge from Big Island Pond amount to 10,500 cfs.
Peak inflow from addition watershed $= 950(23.5 - 16.7)$
$= 6500$ cfs
Total peak inflow rate $= 17000$ cfs
Then by discharge rating curve, $H = 169.7 - 160 = 9.7$ Ft

$STOP1 = 9.7 \times 266 \times 1562 \times 10^{-3} \times 12/23.5 = 2.06$ inch

$QP2 = 17000\left(1 - \frac{2.06}{19}\right) = 15159$ cfs

$H_2 = 169.4 - 160 = 9.4$ Ft

$STOP2 = 9.4 \times 2.06/9.7 = 2.0$ inch

$STOP_{Ave} = \frac{STOP1 + STOP2}{2} = 2.03$ inch

$QP3 = 17000\left(1 - \frac{2.03}{19}\right) = 15184$ cfs, say 15200 cfs.

$H = 169.4 - 160 = 9.4$ Ft about 0.4 ft. overtopping the earth embankments (including dikes)

For any earth embankment, it should never be overtopped, especially without considering the wave effect. Therefore, increase the spillway length is necessary.

j) Improvement.

Assume an additional spillway at elevation 1.5 Ft higher than the existing spillway crest with length of 50 ft. Then when water level at the top of concrete section of the dam, the total spillway capacity would be

$Q = 10260 + 3.8 \times 100 \times 7.5^{3/2} + 1450$
$= 10260 + 7805 + 1450 = 19515$ cfs

with surcharge effect, this additional spillway should be adequate.

Alternative: Based on my experience, probably the other economical alternative is to convert West dike into an additional spillway, that is change the road into bridge with box culverts. Since the height of the west dike is only about 10 ft. it should be easier to convert it into a spillway than Wheeler Dam. Also, originally, the downstream side of the West Dike has a stream, so, the discharge channel still there. The Box Culvert should have a invert elev. 161.5 ft. MSL. so that the flashboards still can be used. The width of the Box Culvert should be determined by detailed flood routing, the height of the Box should be at least 15 ft.

II Visual Inspection and Conclusions.

a) Arlington Mill Reservoir spillway's left retaining wall (Wing Wall) is not high enough, flood flow may over spill from top of the retaining wall and wash out some of the soil near the toe of the dam. Although, the effect on the safety of the dam may not be serious, it is suggested that some riprap should be placed to protect the earth surface.

b) Arlington Mill Reservoir does not have enough spillway capacity to pass the peak inflow of PMF, even by neglecting wave effect and considering surcharge effect. Its normal capacity (with wave effect) only amounts to 6300 cfs and its maximum capacity (neglecting wave effect) amounts to 8600 cfs. Outlet conduits could discharge 1450 cfs. So, the max. total spillway capacity (includes outlet discharge) is about 10,050 cfs. By including one-foot surcharge, to use the concrete gravity section of the dam as additional spillway, it has combined maximum capacity of about 12,600 cfs. The peak inflow of PMF is about 22,330 cfs.

c) Of the three 4-ft diameter outlet conduits only one is operatable at present, the other two have not been used for a long time. If all three can be used as emergency spillway, it would have a capacity of 1406 – 1500 cfs.

d) By assuming that the Big Island Pond Dam would stand overtopping and not fail, its surcharge effect would reduce the peak inflow of PMF to Arlington Mill Reservoir from 22,330 cfs to 17,000 cfs, with the outlet conduits and the reservoir surcharge, an additional spillway is still needed to prevent overtopping its earth embankment.

e) To provide adequate spillway capacity, an additional Ogee spillway with crest elevation at 161.5 M.S.L. with a length of 50 ft is needed.

f) It seems more economical to convert the West Dike into a box culverts bridge type road to provide additional required spillway capacity. As to the height, the width, the invert elevation of the box culverts, all should be determined by detail flood routing.

Greater Lawrence Industrial Corporation
550 Broadway
Lawrence, MA 01840

RE: REQUIRED REPAIRS TO THE FOLLOWING DAMS:

Dam #209.02 (Taylor Dam)

1. Repair abutments.
2. Repair badly eroded floor of chute spillway.

Dam #209.04 (Dike)

1. Remove trees which have started growing on dike.

Dam #209.05 (Wheeler Reservoir)

1. Repair leakage through dam located near gate house.
2. Repair spalling concrete before it becomes critical.

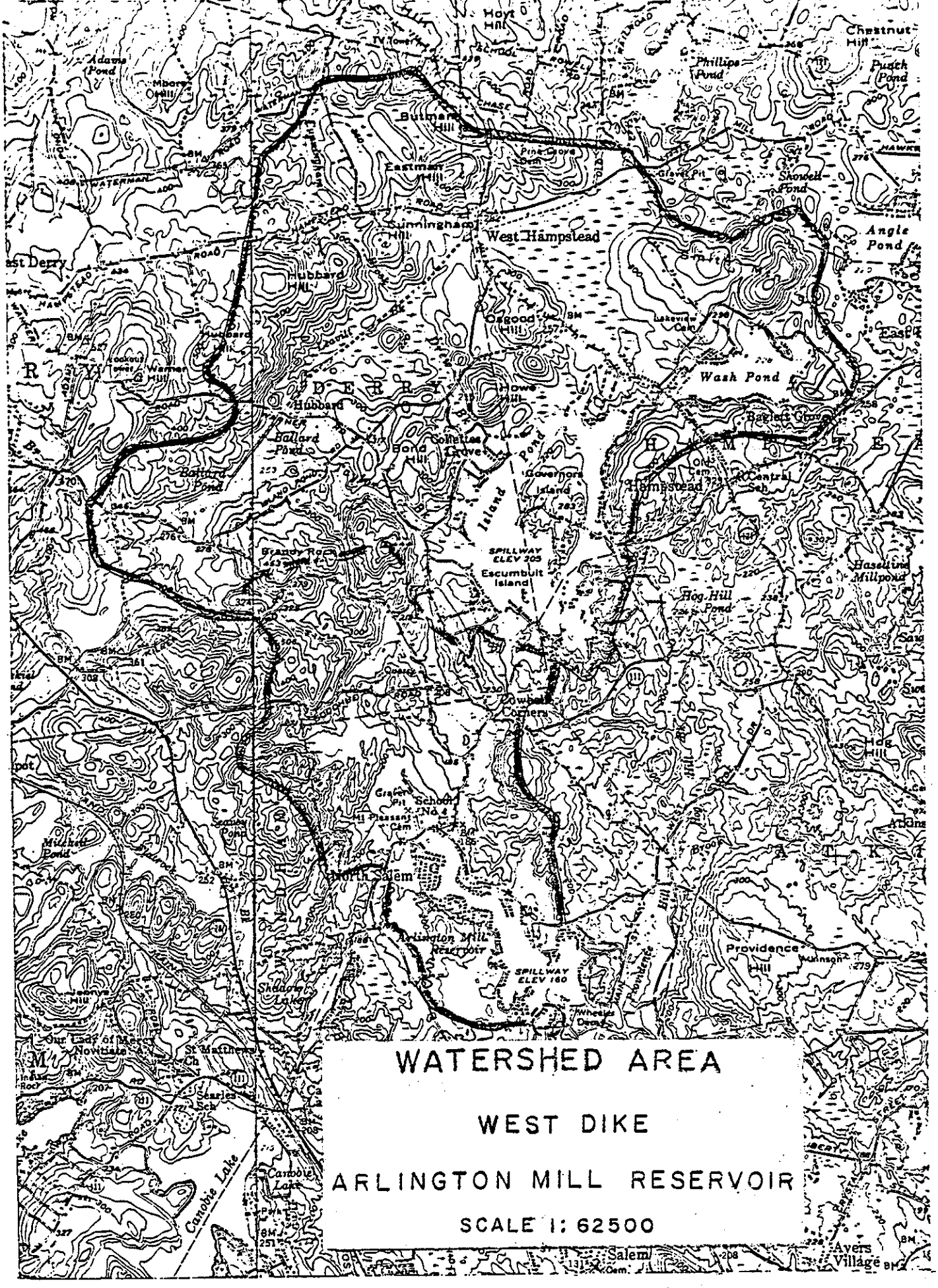
Dam #209.08 Millville)

1. Repair badly spalled and cracked abutments.
2. Repair leakage at location where new concrete has been added (Left spillway)
3. Remove trees and brush from downstream toe and dike.
4. Replace left gate stem.

Dam #209.09 (Canobie Lake)

1. Repair spillway - walls show signs of deterioration.
2. Remove trees from embankment.

zd/js


WATERSHED AREA
WEST DIKE
ARLINGTON MILL RESERVOIR
SCALE 1: 62500
Hoyt Hill
Chestnut Hill
Phillips Pond
Punch Pond
Adams Pond
Butman Hill
Eastman Hill
Pine Grove Cem.
Gravel Pit
Showell Pond
Angle Pond
Cunningham Hill
West Hampstead
Hubbard Hill
Osgood Hill
Wash Pond
Howe Hill
Ballard Pond
Bond Hill
Colletta Drive
Governors Island
Hampstead
Central Sch.
Haseltine Millpond
SPILLWAY ELEV 205
Escumbuit Island
Bog Hill Pond
Cowbell Corners
Gravel Pit
School No. 4
Pleasant Cem.
North Salem
Arlington Mill Reservoir
SPILLWAY ELEV 180
Providence
Wheeler Dam
Shadow Lake
Our Lady of Mercy Novitiate
St Matthews Ch.
Searles Sch.
Canobie Lake
Salem
Salem Cem.
Avers Village
East Derry
Derry

APPENDIX E

INFORMATION AS CONTAINED IN

THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR DIST.	STATE	COUNTY	CONGR DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY	MO	YR
NH	29	NED	NH	015	02				WEST DIKE ARLINGTON MILL RESERVOIR	4248.9	7112.5	15	AUG	78

POPULAR NAME	NAME OF IMPOUNDMENT
	ARLINGTON MILL RESERVOIR

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY—TOWN—VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	04	SPICKET RIVER OFFSTREAM	SALEM	2	20100

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE—FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE—FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
REPG	1922	S	10	7	2890	270	NED	N	N	N	N	07AUG78

REMARKS

D/S HAS	SPILLWAY CREST LENGTH	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO.	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
3	230	N			1220											

OWNER	ENGINEERING BY	CONSTRUCTION BY
SPICKET RIVER CORP	HK BARROWS-CONSULT ENGR	HP CUMMINGS CONSTR CO

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NH WATER RES BD	NH WATER RES BD	NH WATER RES BD	NH WATER RES BD

INSPECTION BY	INSPECTION DATE DAY	MO	YR	AUTHORITY FOR INSPECTION
WHITMAN + HOWARD, INC	07	JUN	78	PL 92-367

REMARKS